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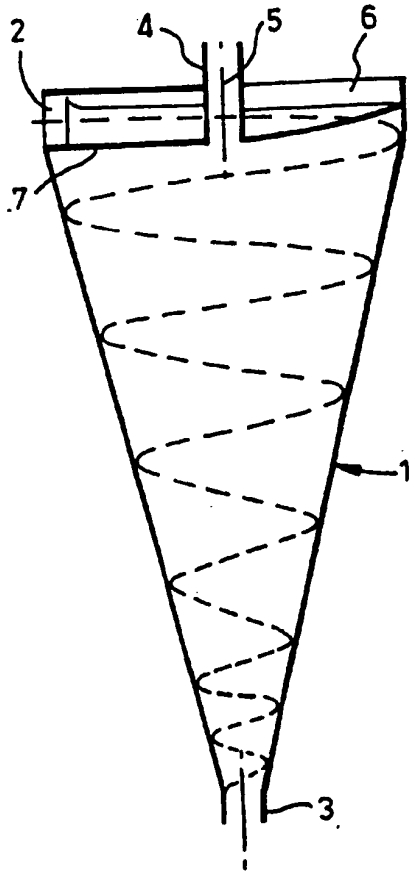
(54) Title: HYDROCYCLONE

(57) Abstract

A liquid/liquid hydrocyclone in which the end wall at the inlet end is helical and is arranged to impart to the mixture through the inlet (2) an axial component of momentum in a direction towards the opposite end of the hydrocyclone.



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HYDROCYCLONE

The present invention relates to a hydrocyclone for separating a liquid mixture into a more dense and a less dense component, the hydrocyclone comprising an elongate separating chamber having a wall profile of the kind suitable for separating two liquids, at least one inlet in the sidewall of the chamber adjacent to one end through which inlet or inlets the mixture enters the chamber, the or each inlet being arranged so that the mixture swirls about the longitudinal axis of the chamber, an underflow outlet at the opposite end of the chamber for removal of the more dense component, and an overflow outlet extending through but not projecting from an end wall at the inlet end of the chamber for removal of the less dense component. Such a hydrocyclone will hereinafter be referred to as of the kind described. Examples of such a hydrocyclone can be found in GB 2248198, GB 2263077 and GB 2263245.

The present invention relates to a modification of a hydrocyclone of the kind described in order to increase its capacity.

According to the present invention, in a hydrocyclone of the kind described, the end wall is inclined so that as the mixture from the or each inlet swirls about the axis of the chamber, the end wall imparts to the mixture an axial component of momentum in a direction towards the opposite end.

This arrangement allows the capacity of a hydrocylone to be increased with minimal change in the separation efficiency. Thus, in any application, the size or number of the hydrocyclones required can be reduced. By imparting axial momentum to the mixture towards the opposite end of the hydrocyclone, short circuiting between the inlet and overflow outlet can be reduced.

Preferably, the end wall is substantially in the form of a helix which gradually extends axially towards the underflow outlet end as the circumferential distance away

from the or a respective inlet in the direction of swirl of the mixture increases and terminates in a step adjacent to the inlet or the next inlet in the direction of swirl of the mixture. With this configuration, when multiple inlets are used, the flow through one inlet can be directed past the flow through the next inlet in the direction of swirl of the mixture, so that the turbulence at the inlet end can be reduced.

If the hydrocyclone is configured to remove oil from an oil/water mixture containing predominantly oil, it is preferable for the ratio of the diameter of the overflow outlet to the diameter of the separating chamber adjacent to the inlet to be less than or equal to 0.15, both diameters being measured in a plane perpendicular to the longitudinal axis.

Two examples of hydrocyclones constructed in accordance with the present invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1 shows a section of a hydrocyclone having a single inlet; and

Fig. 2 shows the profile of the inlet end wall of a hydrocyclone having two inlets.

The hydrocyclone shown in Fig. 1 is, in most respects, a standard de-oiling hydrocyclone. Thus, the hydrocyclone has a separating chamber 1 which is provided at one end with a tangential or involute inlet 2, and at the opposite end with an underflow outlet 3, and gradually tapers from the inlet end to the underflow outlet end. The end wall at the inlet end is provided with an overflow outlet 4. In normal operation, the liquid mixture entering the separating chamber 1 through the inlet 2 swirls about the longitudinal axis 5 of the hydrocyclone causing centrifugal separation of the liquid mixture, so that a more dense component of the mixture flows out through the underflow outlet 3, while a less dense component flows out through the overflow outlet 4.

The end wall of the separator adjacent to the inlet 2 has an inclined surface 6 which has a substantially helical configuration. The helix is of generally uniform pitch, so that it presents an inclined surface to the incoming mixture. The inclined surface 6 terminates at a step 7. As can be seen from the dashed line representing the flow path in Fig. 1, the extent of the step is such that the mixture which has undergone one complete revolution within the separating chamber 1 is axially below the level of the inlet 2, so that the two streams do not interfere with one another.

Fig. 2 illustrates the end wall of a hydrocyclone having two inlets through which flow enters in the direction of the two arrows in Fig. 2. Each inlet is associated with a substantially helical surface 6'. Each helical surface terminates in a step 7', which ensures that the mixture entering through one inlet does not interfere with that entering through the next inlet.

CLAIMS

1. A hydrocyclone for separating a liquid mixture into a more dense and a less dense component, the hydrocyclone comprising an elongate separating chamber (1) having a wall profile of the kind suitable for separating two liquids, at least one inlet (2) in the sidewall of the chamber adjacent to one end through which inlet or inlets the mixture enters the chamber, the or each inlet being arranged so that the mixture swirls about the longitudinal axis (5) of the chamber, an underflow outlet (3) at the opposite end of the chamber for removal of the more dense component, and an overflow outlet (4) extending through but not projecting from an end wall at the inlet end of the chamber for removal of the less dense component; characterised in that the end wall is inclined so that as the mixture from the or each inlet (2) swirls about the axis of the chamber, the end wall imparts to the mixture an axial component of momentum in a direction towards the opposite end.

2. A hydrocyclone according to claim 1, wherein the end wall is substantially in the form of a helix (6) which gradually extends axially towards the underflow outlet end (3) as the circumferential distance away from the or a respective inlet (2) in the direction of swirl of the mixture increases and terminates in a step (7) adjacent to the inlet or the next inlet in the direction of swirl of the mixture.

3. A hydrocyclone according to claim 1 or claim 2, wherein there are a plurality of inlets (2).

4. A hydrocyclone according to any one of the preceding claims, wherein the wall profile of the separating chamber (1) between the two ends is of the kind suitable for separating oil and water.

5. A hydrocyclone according to any one of the preceding claims, wherein the ratio of the diameter of the overflow outlet (4) to the diameter of the separating chamber (1) adjacent to the inlet (2) is less than or equal to 0.15, both diameters being measured in a plane perpendicular to the longitudinal axis (5).

Fig.1.

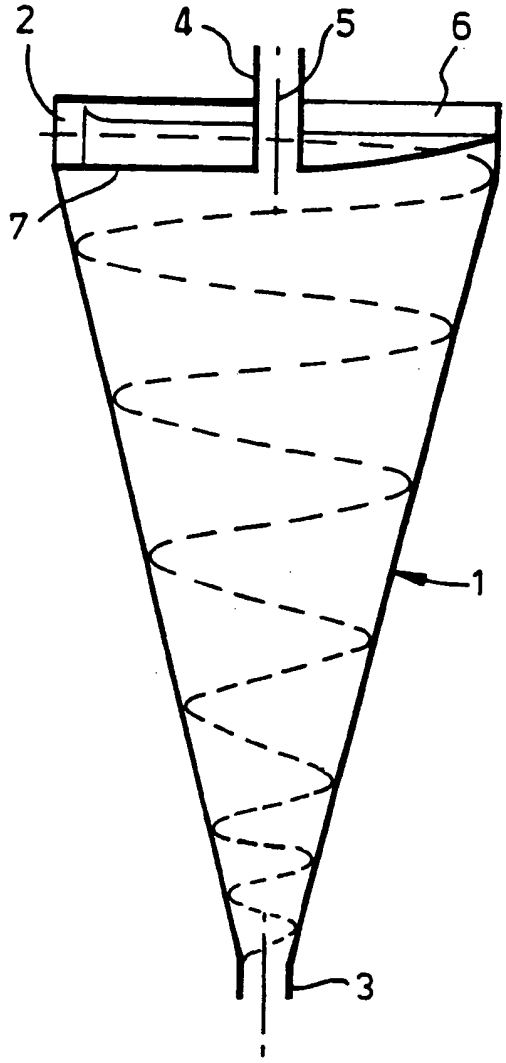
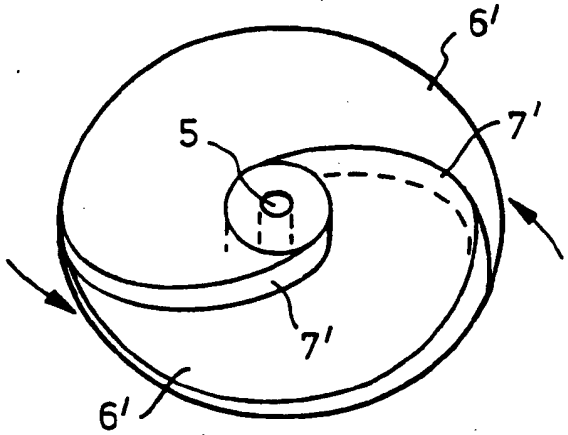


Fig.2.



INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/GB 96/01946

A. CLASSIFICATION OF SUBJECT MA
IPC 6 B04C5/02 B0[redacted]/081

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B04C B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,3 494 474 (M. ESTABROOK) 10 February 1970 see column 2, line 31 - column 4, line 14 see figures 1-7	1,2
A	US,A,3 288 300 (C. BOUCHILLON) 29 November 1966 see column 2, line 15 - column 3, line 72 see figures	1,2
A	WO,A,86 07548 (VORTOIL) 31 December 1986 see page 1, line 1 - line 5 see page 9, line 21 - page 10, line 31 see figures	1,3-5
A	GB,A,2 248 198 (CONOCO SPECIALTY PRODUCTS) 1 April 1992 cited in the application	

☐ Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
14 November 1996	26.11.96

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inten. nal Application No
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-3494474	10-02-70	NONE		
US-A-3288300	29-11-66	GB-A-	955308	
WO-A-8607548	31-12-86	AU-A-	5973090	01-11-90
		AU-B-	596107	26-04-90
		AU-A-	5999286	13-01-87
		DE-A-	3682907	23-01-92
		EP-A-	0267187	18-05-88
		GB-A,B	2198973	29-06-88
		JP-T-	62503082	10-12-87
		NL-T-	8620259	01-03-88
		OA-A-	8789	31-03-89
		US-A-	4793924	27-12-88
GB-A-2248198	01-04-92	US-A-	5110471	05-05-92
		AU-B-	643560	18-11-93
		AU-A-	8513491	30-03-92
		CA-A-	2090618	01-03-92
		CN-A-	1060233	15-04-92
		EP-A-	0544801	09-06-93
		HK-A-	32896	08-03-96
		JP-T-	6500262	13-01-94
		OA-A-	9801	15-04-94
		WO-A-	9204123	19-03-92